

KUWAIT UNIVERSITY
College of Engineering & Petroleum
CHEMICAL ENGINEERING DEPARTMENT
SECOND SEMESTER 2010- 2011

Transport Phenomena (ChE 545)

<u>Instructor</u>	:	Prof. M. R. Riazi Office : 5 th floor, Bldg. 8 Kh. Tel. Ext. # 5772 (Dept. Direct # 4817662)
<u>Office Hours</u>	:	Sunday, Tuesday, Thursday (9:00 –11:00) Monday 10:00-12:00.
<u>Assistant</u>	:	Engr. Sahar Office: Bldg. 9 Kh., Ext. 5695.
<u>Class Hours</u>	:	Monday and Wednesday (5:30 - 7:00 p.m.)
<u>Place</u>	:	Bldg. 6 Kh., Room # 305

COURSE OBJECTIVE:

In this course development of basic field equations in momentum, heat and mass transfer processes are discussed. Use of thermodynamics and characteristics of molecular diffusion are also discussed. Problems of heat and mass transfer in absence of flow field and when flow fields are induced by external forces or body forces are introduced. Special problems such as entrance flow & boundary layer flow in fluid mechanics and moving boundary problems in heat and mass transfer with emphasize in dimensional analysis and finite-difference solutions are discussed.

Some interesting problems in heat and mass transfer directly taken from various industries related to polymer engineering, reaction engineering, sea water desalination and air/water pollution control will be presented to the students throughout the course. Finally application of molecular diffusion in petroleum reservoir fluids during gas injection projects is shown at the end of the course.

- Text Book:**
1. *Main Reference*
"TRANSPORT PHENOMENA"
by: Bird; Stewart; Lightfoot – Wiley & Sons.
 2. *Supplementary References:*
"MATHEMATICS OF DIFFUSION"
by: J. Crank – Oxford Press.
 3. "Characterization and Properties of Petroleum"
<http://www.astm.org/mnl50.htm>
Chapter 6 (Parts 6.2, 6.4, 6.6, 6.8.1, 6.8.2.1), Chapter 8,
Chapter 9 (Section 9.6)
 4. **INSTRUCTOR'S NOTES AND HANDOUTS**

Grading:

The course grade will be based (approximately) on the following considerations:

Homework & Other Assignments	:	20%
Mid-Term Exam	:	35%
Final Exam	:	45%

COURSE OUTLINE

- 1. INTRODUCTION**
- 2. A PHILOSOPHY OF PROCESS ANALYSIS**
- 3. FLUID MECHANICS**
 - a. Continuity Equation
 - b. Conservation of Momentum - Equations of Motion
 - c. Navier - Stokes Equations
 - d. Creeping Flow
 - e. Boundary Layer Flow
 - f. Entrance Flow Problem
- 4. USE OF THERMODYNAMICS IN MASS TRANSFER**
- 5. MOLECULAR DIFFUSION AND MASS TRANSFER**
 - a. Principles
 - b. Characteristics of Diffusion Coefficients
 - c. Flow Field Induced by Molecular Diffusion
 - d. Conservation of Mass of Individual Species
- 6. CONSERVATION OF ENERGY**
- 7. GENERAL CLASSIFICATION OF HEAT AND MASS TRANSFER PROBLEMS**
 - a. Transfer in Absence of Flow Field
 - b. Flow Field Induced by External Forces
 - c. Flow Field Induced by Body Forces
- 8. MOVING BOUNDARY PROBLEMS**
- 9. FINITE - DIFFERENCE SOLUTIONS OF TRANSPORT PROBLEMS**
- 10. MISCELLANEOUS TOPICS & PROBLEMS**
 - a. Measurement of Diffusion Coefficients
 - b. Molecular Diffusion in Petroleum Reservoir Fluids
 - c. Design of Falling Film Reactors
 - d. Rate of Oil Removal from Sea Water by Evaporation and Dissolution
 - e. Problem of Heat Transfer to a Polymer Melt

- f. Special Problems on Removal of Hydrocarbon Impurities from Air and Waste Water Stream
- g. Special Problem on Reverse Osmosis for Desalination of Sea Water